

A comprehensive review on kidney stones, its diagnosis and treatment with allopathic and ayurvedic medicines

Abstract

Kidney stone is a major problem in India as well as in developing countries. The kidney stone generally affected 10-12% of industrialized population. Most of the human beings develop kidney stone at later in their life. Kidney stones are the most commonly seen in both males and females. Obesity is one of the major risk factor for developing stones. The common cause of kidney stones include the crystals of calcium oxalate, high level of uric acid and low amount of citrate in the body. A small reduction in urinary oxalate has been found to be associated with significant reduction in the formation of calcium oxalate stones; hence, oxalate-rich foods like cucumber, green peppers, beetroot, spinach, soya bean, chocolate, rhubarb, popcorn, and sweet potato advised to avoid. Mostly kidney stone affect the parts of body like kidney ureters and urethra. More important, kidney stone is a recurrent disorder with life time recurrence risk reported to be as high as 50% by calcium oxalate crystals. Calcium oxalate occurred kidney stones is the most common stone reported in India. Therefore, due to disease of kidney stones there is a higher chance of developing heart diseases which are now detected in India and the rest World. Kidney stones forms lower the minerals in the body as well as reduced the essential element for bone formation. The patients detects higher lipid level in the blood may have the tendency to develop kidneys stones as compared to normal individuals. The patients have advice to take low fat diet and fibers of natural occurring plants and its herbal medicines. The combination of herbal medicines with allopathic treatment have a great idea to get rid all the complications related to kidney stones.

Keywords: calcium oxalate crystals, thiazides, fenugreek seeds, shatavari root

Volume 7 Issue 4 - 2019

Firoz Khan,¹ Md Faheem Haider,¹ Maneesh Kumar Singh,¹ Parul Sharma,¹ Tinku Kumar,² Esmaeili Nezhad Neda³

¹College of Medical Sciences, IIMT University, India

²Department of Pharmacy, Shri Gopichand College of Pharmacy, India

³Department of Medicinal Plants, Islamic Azad University of Bijnord, Iran

Correspondence: Firoz Khan, Asst. Professor, M Pharm. Pharmacology, IIMT University, Meerut, U.P- 250001, India, Tel +91-8433414638, Email fkpharmacy@gmail.com

Received: July 13, 2019 | **Published:** August 02, 2019

Introduction

The urinary system consists of two major bean shaped kidneys, ureters, bladder and urethra. These bean shaped kidneys located just middle of the back and below the pairs of ribs. Kidneys transport water and body wastes from the circulating blood and then converts it to form urine.¹ These are also useful for making a equilibrium balance of salts and other ions in the blood. The tubes of the urethras which are narrow in size; carry the composition of urine from the kidneys which transport to a triangle shaped chamber called bladder. At the same time, urine stored in a elastic, balloon type chamber called bladder which get flatten when urine is removed through urethra to out the body.² The term 'Urolithiasis' is a global problem affecting human beings for ancient times and also called 'Nephrolithiasis' or kidney stones. Urolithiasis is a condition in which the crystals of uroliths/stones present in the urinary tract. In the western world, annual incidence of Urolithiasis is about 0.5% with lifetime risk of developing is about 10-15% but it increasing with 20-25% in the Middle East. Urolithiasis is the formation of uneven calculi, or the condition which belongs to urinary calculi.³ The condition of calculi is synonymous with the term uroliths, stones, or crystals. These calculi/stones are made by deposition of polycrystalline aggregates composed of different amounts of crystalloid and organic matrix. These calculi can different in size and shape which found anywhere in the urinary tract from kidney to the bladder.⁴

Composition of kidney stone

A kidney stone is a cluster of crystals when they formed together to create a hard lump in one or both kidneys. They can vary in size from a few millimeters to several centimeters. The majority of stones will pass out of the body in the urine without any help, but some will require intervention to remove them. The Urinary stone have been developed with the crystals of phosphate, uric acid, magnesium ammonium phosphate with apatite and struvite.⁵ Among the urinary stones, calcium- containing stones have been found to about 75% of all urinary calculi, which may be present in the form of crystals of pure calcium oxalate (50%), calcium phosphate (5%) and a mixture of both compounds (45%). The diet can affect the concentration of certain substances in the urine and can affect the acidity of urine. The 24 hour urine collection of urine may found any of the given properties have increased risk of forming a stone:

- I. High levels of calcium (hypercalciuria)
- II. High levels of oxalate (hyperoxaluria)
- III. High levels of uric acid (hyperuricaemia)
- IV. Low levels of citrate (hypocitraturia)⁶

Calcium, oxalate, uric acid and citrate are normal substances found in the blood. The acidity of any fluid are expressed as pH. The pH

of less than 7 is called acidic while pH greater than 7 is belongs to alkaline. Normal urine pH will vary during the day depending on diet and will usually range between 5 and 8. Calcium oxalate stones can be found in any pH of urine. The formation of uric acid stones is more in acidic urine while calcium phosphate stones form in more alkaline urine (Figure 1).⁷

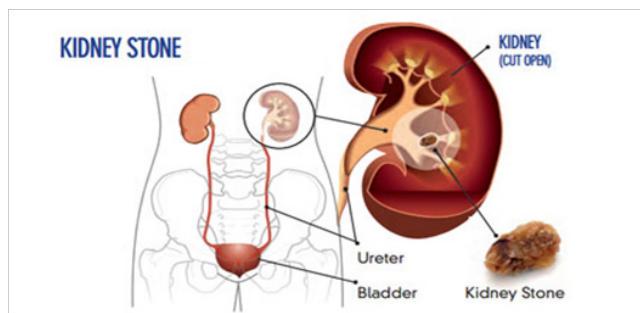


Figure 1 Location of Kidney stone.

Types of kidney stones

There are four major types of stone are deposit in kidneys which are- calcium (75 to 85%), struvite (2 to 15%), uric acid (6 to 10%) and stones of cystine (1 to 2%). The distribution and frequency of these stones is depending upon the geographical location of living being and population studied. Rarely, the long term used of drugs causes the kidneys stones which are about 1%.⁸

Calcium stones

The stones of calcium oxalate, calcium urate and calcium phosphate are associated with hypercalciuria which caused by hyperparathyroidism. People associated with disease, increased calcium absorption from the gut causes renal calcium or phosphate leak, hyperuricosuria, hyperoxaluria, hypocitraturia and hypomagnesuria developed.⁹

Struvite stones

Struvite is composed of magnesium ammonium phosphate stones which grow to fill the collecting system (partial or complete staghorn calculi). This stage is developed due to chronic urinary tract infections which caused by Gram-negative urea-splitting rods including *Proteus*, *Pseudomonas* and *Klebsiella* species.¹⁰

Uric acid stones

The formation of uric acid stones depend upon high purine intake drugs or high cell turnover (e.g. malignancy) which are mostly found in patients with gout. Uric acid stones mostly form in slightly acidic urine (pH 5.5). They are visible in nature and usually radiolucent on X-ray film.¹¹

Cystine stones

Cystine stones become due to having hereditary intrinsic metabolic disorder called cystinuria in which the re-absorption of cystine in the renal tubule is impaired. These stones could difficult to find on X-rays because of high sulphur content. In drug-induced stones, several drugs can participate in the formation of renal stones.¹²

Drug-induced stones

Some drugs are also participating in the formation of renal stones which can be used for another disease. They are indinavir, atazanavir,

guaifenesin, triamterene, silicate (antacids) and sulfa drugs. These stones are rare and are always seen on X-Rays (radiolucent).¹³

Sign & symptoms

The subject did not identify weather he is suffering from kidney stones, it do not cause any symptoms to be observed without identification. After leaving the stone through kidney, it passed to the bladder through the help of ureters. At the same time some of the stones remain in the ureters, they block the urine flow out of the kidneys and make it to swell; this condition is called as hydronephrosis. This caused a lot of pain in the kidneys. Common symptoms of kidney stones are verified by.¹⁴

- I. An acute, sudden, sharp and wavy pain in the back and its whole side, which can be moved to the lower abdomen or genital space. Some of the women patients say the pain which is worse than childbirth labor pains. It makes a situation of come and go pain with discomfort. The sign and symptoms are-
- II. A feeling of sudden urinate.¹⁵
- III. Burning feeling at urination.
- IV. The color of the urine will be dark or red due to blood particles of RBCs. In some cases the color of the blood is very less that is not seen by naked eyes.
- V. Feeling of nausea and vomiting.
- VI. Male patients feel pain at the tip of their penis.¹⁶

Risk of factors

Dietary factors are major key points to promote or inhibit kidney stone formation. The stone can be formed by other factors which include environment, body weight, genes and how much of fluid intake. The following of the factors which can increase the risk of promoting kidney stones.¹⁷

- I. Dehydration of the body
- II. Kidney stones may be come by genetically. Cystinuria is a genetic disorder increased the risk of developing cystine stones
- III. Taking more amounts of proteins, fats, sodium and sugar in the diet may increase the risk of kidney stones.
- IV. People having kidney infections (especially women) and urinary tract infections (UTIs) can develop more easily struvite stones compare to other diseases
- V. Metabolic syndrome developed kidney stones
- VI. Obesity may increase risk of kidney stones.¹⁸

Diagnosis

Blood testing: Blood tests measure too much of calcium or uric acid in the blood. Blood test results help monitor the health of the kidneys and may lead doctor to check for other medical conditions.¹⁹

Urine testing: The 24-hour urine collection test may show that the kidneys excreting too many stone-forming minerals or too few stone-preventing substances. For this test, doctor may request that at least perform two urine collections over two consecutive days.²⁰

Imaging: Imaging tests may show the availability of kidney stones in urinary tract. Options range from simple abdominal X-rays, which can miss small kidney stones, to high-speed or dual energy computerized tomography (CT) that capture even tiny stones.²¹ Other imaging options include an ultrasound, a noninvasive test, and intravenous urography, which involves injecting dye into an arm vein and taking X-rays (intravenous pyelogram) or obtaining CT images (CT urogram) as the dye travels through the kidneys and bladder.²²

Pathophysiology of urinary stone

The pathogenesis of Urolithiasis is complex to describe it encompassing several physicochemical events occurring sequentially or concurrently. Despite increasing study in the last decade the mechanisms whereby calcium oxalate crystals are retained in the kidney and form renal stones remain incompletely understood.²³ Formation of stone required supersaturated ionic urine. The level of super-saturation is also depends on urinary pH, ionic strength, solute concentration in the urine and complications. Three conditions must coexist for the formation of Struvite calculi.

- I. Alkaline Ph of urine,
- II. The availability of urea or ammonia in the urine
- III. High amount of minerals in the urine.²⁴

Treatment of kidney/urinary stones

Small stones

The small stones do not require much treatment; they get off the body by drinking precise amount of water. Drinking plenty of water to about 4-5 lit/day helps to get rid of stones throughout the body through urine. The movement of stones creates pain; the moving pain can be treated with certain pain relievers.²⁵

Medical therapy for kidney stones: Usually doctors prescribe with alpha blockers; they relax the muscles in the ureters, which help to pass the kidney stone more quickly. Diuretics are also useful for increasing the urine flow to pull out the stone.²⁶

Large stones

Large stones are not easy to remove by drinking plenty of water they cannot pass out from the body due to stuck in the renal tube. These stones may harmful for body because they can damage the kidneys and cause internal bleeding, loss of Nephron or easy to get infected with some urinary tract infections. The larger stones cannot pass throughout from the kidneys because they are large in shape and are may be chances of break down. They also cause bleeding, UTIs and damage in kidneys.²⁷

Extracorporeal shock wave lithotripsy

In this process the large kidney stones are broken into small pieces by using sound waves or shock waves to create strong vibrations. The small pieces of broken stones can be flushed out of the body through urine (Figure 2).²⁸

Nephrolithotomy

If the doctors find the large stones in or near kidneys the Nephrolithotomy is one of the options. During this surgery the patient receives general anesthesia. The device contains a thin telescopic instrument which removes the kidney stones which is more than in 2 cm in size. This instrument is better used for the stones near the pelvic region.²⁹

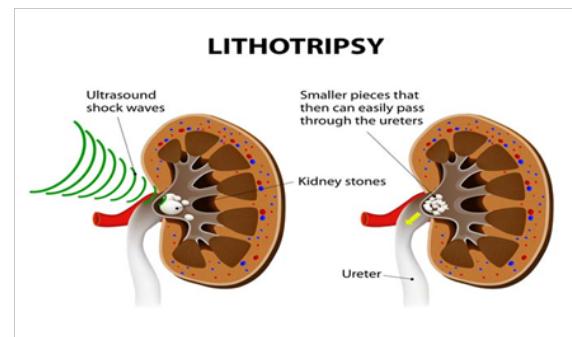


Figure 2 Shock wave lithotripsy.

Ureteroscopy

Ureteroscopy is the procedure for removing stones which gets stuck in the ureters or bladder. Ureteroscopy can be examined the upper urinary tract stones. This procedure is painful and contains a small wire which connects with a camera at the end. The wire is inserted into the urethra and passed into the bladder for removal of stones with a cage connected with it (Figure 3).³⁰

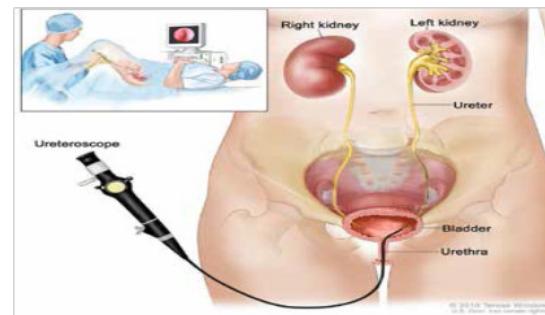


Figure 3 Removal of kidney stones by Ureteroscopy.

Treatment through allopathic medicines

Modification of diet and taking more fluids is not enough to prevent the formation of kidney stones. Doctors should prescribe the medication to get rid of formed stones in the body. The type, size of stone and the urine abnormalities can decide the medication which is best. The medications which are used for removal of stones are given below.³¹

Thiazide diuretics

Thiazides are useful for patients contain high amount of calcium in urine as well as calcium stones in the kidneys. These drugs help the kidneys to remove excessive calcium out of the body and prevent formation of calcium stones (transport back into the blood stream). Thiazides are useful in low sodium diet intake, with measured quantity of salt used in the diet.³²

Potassium citrate

Potassium citrate is used to make urine less acidic and useful for patients suffering from uric acid stones, calcium and cystine stones with low urinary citrate. Potassium citrate makes the urine more alkaline basic. This property helps to prevent formation of cystine and uric acid stones. The citrate level also increased in the urine, which helps to prevent generation of calcium stones.³³

Allopurinol

Allopurinol is used in the treatment of gout, increases the amount of uric acid in the blood that deposits in the cavity of joints. Allopurinol

lowers the raised amount of uric acid in the blood and urine. It also prescribed to prevent the calcium and uric acid stones in the kidneys.³⁴

Acetohydroxamic acid (AHA)

Acetohydroxamic acid is used for the patients having to produce struvite stone or infection in the UTIs. This type of stones can be formed due to repeat of urinary tract infections. AHA can dilute the urine and make it unfavorable for the formation of struvite stones. The inhibition of struvite stones is prevented by blocking the action of repeated UTIs which is caused by some specific types of bacteria. The stones can be completely removed by surgery.³⁵

Herbal treatment of kidney stone

Herbs and herbal drugs are useful in the treatment of kidney stones. These drugs have created interest among the people by its clinically proven effects like immunomodulation, adaptogenic and antimutagenic effect. Also, the over use of synthetic drugs; results in higher incidence of adverse drug reactions, has motivated to humans for return to use of natural remedies.

Celosia argental (Viratarvadigana): Indian system of medicine is considered to be specific for the treatment of urinary stone. Its aqueous decoction is used for the dissolution and excretion of stones. Didymocarpus pedicellata, commonly known as Patharphodi or Shila pushp is useful for kidney and bladder stones.³⁶

Fenugreek seed (*Trigonella foenum-graecum*): The seeds of this herb are commonly used in northern Africa to prevent and treat kidney stones. In an animal study it was found that Fenugreek seed significantly reduced calcification in the kidney and helped prevent kidney stones.³⁷

Shatavari root (*Asparagus racehorses*): This important Ayurvedic Ramayana (rejuvenative remedy) was found to inhibit formation of calcium oxalate stones in test animals.³⁸

Chanca piedra/Stonebreaker (*Phyllanthus niruri*): The Chanca stone breaker is may be used of tropics and has a long history of use for helping to prevent and pass kidney stones. In several in vitro and animal studies, daily intake of this herb helped to prevent the formation of kidney stones.³⁹

Gokshura fruit/root (*Tribulus terrestris*): This herb is an Ayurvedic rasayana, nephroprotective agent, and is commonly used in India and China to treat urinary tract disease. In animal studies it prevented the formation of kidney stones and may have even helped to reverse early stage Urolithiasis. In vitro research supports the animal data and further suggests that Tibullus also protects against calcium oxalate induced renal injure.⁴⁰

Origanum vulgare: This plant is widely used as spice and medicine; work as lithotripter, diuretic, Anti antispasmodic in nature. The crude aqueous metabolic extract of the aerial part of O. vulgare exhibited in vitro inhibitory activity in the nucleation and aggregation of calcium oxalate crystals, and also decreased the number of crystals produced in calcium oxalate detestable solutions.⁴¹

Barberry root bark (*Berberis vulgaris*): Barberry was found to inhibit calcium oxalate crystallization and prevent kidney damage caused by oxidative stress. The water extract was the most effective preparation.⁴²

Chanca Piedra/Stonebreaker (*Phyllanthus niruri*): Is native to the tropics and has a long history of use for helping to prevent and pass

kidney stones. In several in vitro and animal studies, daily intake of this herb helped to prevent the formation of kidney stones.⁴³

Black cumin seed (*Nigella sativa*): In animal studies the use of this herb significantly protected test animals against experimentally induced formation of calcium oxalate stones.⁴⁴

Punarnava herb (*Boerhaavia diffusa*): This common Indian weed is used as a kidney restorative and to help expel kidney stones. In an in vitro study it was able to inhibit formation of struvite stones; whether it can do this in vivo is unknown.⁴⁵

Varuna bark (*Crataeva nurvala*): Daily intake of this Ayurvedic herb reduced urinary calcium excretion and kidney stone formation. This Ayurvedic herb is used to help prevent kidney stones (see page 5) and it also used with banana stem (Musa paradisiaca) for successfully treating kidney stones. In recent human study, the authors state that this formula “helped to dissolve renal calculi, facilitated their passage and reduced pain.⁴⁶

Evening primrose seed oil (*Oenothera biennis*): In a human study, daily ingestion of EPO (1000 mg perday) significantly increased citraturia (urinary citrate levels) while reducing urinary oxalate, calcium and the Tiselius risk index, which is a measurement of risk for Forming kidney stones.⁴⁷

Rupture wort herb (*Herniaria hirsuta*): In animal studies this herb inhibited deposition of CAOx crystalline the test animals' kidneys.⁴⁸

Ammi visnaga: Different type of tea prepared from the fruits of Ammi visnaga have been traditionally used by patients with renal stones in Egypt as well as in the World.⁴⁹ The aqueous extract of this fruit accelerated the dissolution of cystine stones in the kidneys. The fruit and its two major constituents, namely khellin and visnagin which showed beneficial effects in the management of kidney stone disease caused by hyperoxaluria.⁵⁰

Hibiscus sabdariffa

This belongs to Thai traditional medicine, Hibiscus sabdariffa is used for the prophylaxis and treatment of urinary stones.⁵¹ A clinical trial done, which had tested a cup of tea made from 1.5 g of dry H. sabdariffa, which was taking two times daily on 18 patients for 15 days revealed uricosuric effect and significant increase in uric acid excretion and clearance from kidneys by urine.⁵²

Conclusion

Kidneys stone is one of most common problems in developing countries and rest of the World which affects urinary system. Some of the medical condition increase the risk of kidney stones problems such as high fat diet, inadequate nutrition, addition of food that contains oxalate crystals, high protein diet and post surgery defects. The stones can be developed by common physiological functions such as abnormal growth of Para thyroid glands, which controls the metabolism of calcium. This condition creates high level of calcium in the blood and urine which causes kidney stones. Kidney Stone disease continues to be a growing problem. Kidney Stone formation depends upon various factors such as like metabolic, environmental, and nutritional factors. Improvement of diagnostic modalities has led to a better understanding of the disease. Some technique for the treatment of kidney stone such as allopathic and herbal medication or removal of stones through surgery is now in trends. But most of the people preferred herbal therapy for removal of kidney stones.

Herbal treatment is the safest and inexpensive treatment ever but the treatment needs time for their effect.

Acknowledgements

None.

Funding details

None.

Conflict of Interest

Author having lots of interest regarding the public health issue, reporting possible or non-possible adverse drug reaction detect by allopathic and traditionally using medicines.

References

- Manjula K, Pazhanichami K, Rajendran S, et al. Herbal Remedy for Urinary Stones. *Scientific Publishers (India)*. 2015;203:4–13.
- Guy's, St Thomas. *NHS Foundation Trust*. Diet and lifestyle advice for the prevention of kidney stones. 2104;(5):16.
- Harika G, Srinivas K. Renal Calculus A Brief Review. *Research and Review Journal and medical and health Science*. 2104;5(3):2–7.
- Peachtree D, Atlanta GA, kidney stones. *Urologist specialist*. 2011;4–11.
- Callaghan D, Bandyopadhyay BC. Calcium phosphate kidney stone: problems and perspectives. *J Physiol*. 2012;6(8):118–125.
- Kawano PR, Cunha N,B, Silva IBL, et al. Effect of dietary supplementation of vitamin d on ethylene glycol-induced Nephrolithiasis in rats. *J Nut Food Sci*. 2016;5(3):342–499.
- Choubey A, Parasar A, Patil UK, et al. Potential of medicinal plant in kidney gall and urinary stone. *International Journal of Drug Development & Research*. 2010;2(2):436–440.
- Stamatelou KK, Francis ME, Jones CA, et al. Time trends in reported prevalence of kidney stones in the United States: 1976-1994. *Kidney Int*. 2003;63(5):1817–1823.
- Soucie JM, Thun MJ, Coates RJ, et al. Demographic and geographic variability of kidney stones in the United States. *Kidney Int*. 1994;46(3):893–899.
- Lee YH, Huang WC, Tsai JY, et al. Epidemiological studies on the prevalence of upper urinary calculi in Taiwan. *Urol Int*. 2002;68(3):172–177.
- Safarinejad MR. Adult urolithiasis in a populationbased study in Iran: prevalence, incidence, and associated risk factors. *Urol Res*. 2007;35(2):73–82.
- Scales CD Jr, Smith AC, Hanley JM, et al. Prevalence of kidney stones in the United States. *Eur Urol*. 2012;62(1):160–165.
- Trinchieri A, Coppi F, Montanari E. Increase in the prevalence of symptomatic upper urinary tract stones during the last ten years. *Eur Urol*. 2000;37(11):23–27.
- Trinchieri A, Ostini F, Nespoli R, et al. A prospective study of recurrence rate and risk factors for recurrence after a first renal stone. *J Urol*. 1999;162(1):27–30.
- Levy FL, Adams-Huet B, Pak CY. Ambulatory evaluation of nephrolithiasis: an update of a 1980 protocol. *Am J Med*. 1995;98(1):46–50.
- Pak CY, Britton F, Peterson R, et al. Ambulatory evaluation of nephrolithiasis. Classification, clinical presentation and diagnostic criteria. *Am J Med*. 1980;69(1):19–30.
- Su CJ, Shevock PN, Khan SR, et al. Effect of magnesium on calcium oxalate urolithiasis. *J Urol*. 1991;145(5):1092–1095.
- Ettinger B, Citron JT, Livermore B, et al. Chlorthalidone reduces calcium oxalate calculous recurrence but magnesium hydroxide does not. *J Urol*. 1988;139(4):679–984.
- Pak CY, Sakhaee K, Fuller C. Successful management of uric acid nephrolithiasis with potassium citrate. *Kidney Int*. 1986;30(3):422–428.
- Coe FL, Clark C, Parks JH, et al. Solid phase assay of urine cystine supersaturation in the presence of cystine binding drugs. *J Urol*. 2001;166(2):688–693.
- Dolin DJ, Asplin JR, Flagel L, et al. Effect of cystinebinding thiol drugs on urinary cystine capacity in patients with cystinuria. *J Endourol*. 2005;19(3):429–432.
- Griffith DP, Khonsari F, Skurnick JH, et al. A randomized trial of acetohydroxamic acid for the treatment and prevention of infection-induced urinary stones in spinal cord injury patients. *J Urol*. 1988;140(2):318–324.
- Borghi L, Meschi T, Schianchi T, et al. Urine volume: stone risk factor and preventive measure. *Nephron*. 1999;81(1):31–36.
- Borghi L, Meschi T, Guerra A, et al. Randomized prospective study of a nonthiazide diuretic, indapamide, in preventing calcium stone recurrences. *J Cardiovasc Pharmacol*. 1993;22(6):78–83.
- Ohkawa M, Tokunaga S, Nakashima T, et al. Thiazide treatment for calcium urolithiasis in patients with idiopathic hypercalcemia. *Br J Urol*. 1992;69(6):571–576.
- Brocks P, Dahl C, Wolf H, et al. Do thiazides prevent recurrent idiopathic renal calcium stones? *Lancet*. 1981;2(8238):124–125.
- Mortensen JT, Schultz A, Ostergaard AH. Thiazides in the prophylactic treatment of recurrent idiopathic kidney stones. *Int Urol Nephrol*. 1986;18(3):265–669.
- Laerum E, Larsen S. Thiazide prophylaxis of urolithiasis. A double-blind study in general practice. *Acta Med Scand*. 1984;215(4):383–389.
- Escribano J, Balaguer A, Pagone F, et al. Pharmacological interventions for preventing complications in idiopathic hypercalcemia. *Cochrane Database Syst Rev*. 2009;(1):47–54.
- Huen SC, Goldfarb DS. Adverse metabolic side effects of thiazides: implications for patients with calcium nephrolithiasis. *J Urol*. 2007;177(4):1238–1243.
- Moe OW, Pearle MS, Sakhaee K. Pharmacotherapy of urolithiasis: evidence from clinical trials. *Kidney Int*. 2011;79(4):385–392.
- Hess B, Jost C, Zipperle L, et al. High-calcium intake abolishes hyperoxaluria and reduces urinary crystallization during a 20-fold normal oxalate load in humans. *Nephrol Dial Transplant* 1998;13(9):2241–2247.
- Duncan SH, Richardson AJ, Kaul P, et al. Oxalobacter formigenes and its potential role in human health. *Appl Environ Microbiol*. 2002;68(38):41–47.
- Holmes RP, Goodman HO, Assimos DG. Contribution of dietary oxalate to urinary oxalate excretion. *Kidney Int*. 2001;59(1):270–276.
- Grentz L, Massey LK. Contribution of dietary oxalate to urinary oxalate health and disease. *Topics in Clinical Nutrition*. 2002;17:60–70.
- Baxmann AC, Mendonca CD, Heilberg IP. Effect of vitamin Cs supplements on urinary oxalate and pH in calcium stone-formingpatients. *Kidney Int*. 2003;63(3):1066–1071.
- Goldfarb DS, Asplin JR. Effect of grapefruit juice on urinary lithogenicity. *J Urol*. 2001;166(1):263–267.

38. Yagisawa T, Ito F, Osaka Y, et al. The influence of sex hormones on renal osteopontin expression and urinary constituents in experimental urolithiasis. *J Urol.* 2001;166(3):1078–1082.
39. Dey J, Creighton A, Lindberg JS, et al. Estrogen replacement increased the citrate and calcium excretion rates in postmenopausal women with recurrent urolithiasis. *J Urol.* 2002;167(1):169–71.
40. Eskelinen M, Ikonen J, Lippinen P. Usefulness of history-taking, physical examination and diagnostic scoring in acute renal colic. *Eur Urol.* 1998;34(6):467–473.
41. Glowacki LS, Beecroft ML, Cook RJ, et al. The natural history of urolithiasis. *J Urol.* 1992;147(2):319–21.
42. Chandhoke PS. When is medical prophylaxis cost effective for recurrent calcium stones? *J Urol.* 2002;168(3):937–940.
43. Cooper JT, Stack GM, Cooper TP. Intensive management of ureteral calculi. *Urology.* 2000;56:575–578.
44. Lopes T, Dias JS, Marcelino J, et al. An assessment of the clinical efficacy of intranasal desmopressin spray in the treatment of renal colic. *BJU Int.* 2001;87(4):322–325.
45. Kober A, Dobrovits M, Djavan B, et al. Local active warming: an effective treatment for pain, anxiety and nausea caused by renal colic. *J Urol.* 2003;170(3):741–744.
46. Segura JW, Preminger GM, Assimos DG, et al. Ureteral stones clinical guidelines panel summary report on the management of ureteral calculi. *J Urol.* 1997;158(5):1915–1921.
47. Auge BK, Preminger GM. Surgical management of urolithiasis. *Endocrinol Metab Clin North Am.* 2002;31(4):1065–82.
48. Sofer M, Watterson JD, Wollin TA, et al. Holmium: YAG laser lithotripsy for upper urinary tract calculi in 598 patients. *J Urol.* 2002;167(1):31–34.
49. Delvecchio FC, Preminger GM. Medical management of stone disease. *Curr Opin Urol.* 2003;13(3):229–233.
50. Parks JH, Goldfischer ER, Coe FL. Changes in urine volume accomplished by physicians treating nephrolithiasis. *J Urol.* 2003;169:863–866.
51. Borghi L, Schianchi T, Meschi T, et al. Comparison of two diets for the prevention of recurrent stones in idiopathic hypercalciuria. *N Engl J Med.* 2002;346:77–84.
52. McHarg T, Rodgers A, Charlton K. Influence of cranberry juice on the urinary risk factors for calcium oxalate stone formation. *BJU Int.* 2003;92(5):676–682.
53. Ratna S, Harika K. Renal Calculus: A Brief Review. *Journal urology and endocrinology.* 2015;5(3):2–9.